CREOSOTING.

BETHELL PROCESS.

PRESERVATION OF TIMBER FROM DECAY AND THE ATTACKS OF MARINE WORMS.

Central Creosoting and Burnettizing Works,

ELIZABETHPORT, N. J.

J. G. MOORE & CO.,

PROPRIETORS.

OFFICE, 96 WALL ST., NEW YORK.

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THE GRAPHIC COMPANY,
39 & 41 PARK PLACE,
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(C 1880)

CREOSOTING.

Messrs. J. G. MOORE & CO., beg leave to call the attention of all gentlemen engaged in works of construction, to the results realized by the use of the "BETHELL CREOSOTING PROCESS" which has been in successful operation in Europe for thirty-six years.

The object in creosoting timber is two-fold; first, to preserve it from wet and dry rot by coagulating the albumen of the sap, and to seal up the pores by the introduction of bituminous matters contained in the oil, thus protecting the fibres from moisture; and, secondly, to protect timber submerged in salt-water, from the attacks of marine worms and insects, experience having proved that creosoted wood is never touched by them.

The works of Messrs. J. G. Moore & Co., are situated at Elizabethport, N. J., on Staten Island Sound, ten miles from New York; they consist of four cylinders, each 6 feet in diameter by 75 feet in length, made of half-inch boiler iron with heavy gun metal heads 3½ inches thick, and capable of withstanding a pressure of 200 lbs. per square inch. The tracks of the C. R. R. of N. J. run parallel to, and within ten feet of these cylinders on one side, while 50 feet from them, on the other side, is a dock front of 900 feet in length with 14 feet depth of water. There are three-and-one-half acres of ground attached to the

works, and every facility is thus afforded for the reception, storage, and shipment of lumber by both land and water.

The process in brief is as follows:

The timber to be treated is loaded upon strongly made, low wheeled cars, chained down, run by steam power into the cylinders, the doors closed and so secured by numerous heavy bolts as to be air tight. A vacuum is then obtained by an air pump worked by an engine of about thirty horse power, the effect being to draw out the air and super-abundant moisture contained in the pores of the wood. After the vacuum has been maintained for the requisite time, the pipe connection between the cylinders and the oil (which is contained in subterranean tanks) is opened by a valve, and the oil, warmed to 100° Fahr., rushes up to fill the vacuum in the cylinders above. An average pressure of about 150 lbs. per square inch is then obtained by the use of a powerful pressure pump, and continued until the requisite quantity of oil is forced into the pores of the wood. From 6 to 7 lbs. per cubic foot is considered by European engineers to be a sufficient absorption for timber used in railroad and other constructions on land, while from 8 to 9 lbs. are used in marine works.

Attention is called to the fact that in this process the wood is not heated either by steam, vapor, fire or hot bath; but that the oil is simply warmed to a temperature but little above that of "summer heat." The fibre, therefore, cannot be injured by this method of application, but on the contrary it is greatly benefitted and strengthened, as is shown by the statements of all scientific and practical men who have written on this subject.

Timber has been, until the last few years, so cheap in America as compared with Europe, that the inducement to

construct works adapted to the preservation of lumber has been in a great measure wanting, but the steady increase in price of late years, together with the rapid diminution of our forests, render some artificial aid to the prolongation of the life of wood a necessity. The U. S. Government, under the able supervision of Major General John Newton and Major General Q. A. Gilmore has adopted this process in the treatment of timber used in the construction of gun beds in New York and some of the Southern ports, and is at present using it in a pile dyke near Staten Island, for the purpose of preserving the piling and timbers from the naval worm, there being ample European evidence to prove that the worm never attacks timber, the pores of which are filled with creosote oil.

The creosoting works in Europe are frequently much embarrassed in their operations by difficulty in obtaining oil of such specific gravity as will admit of ready penetration in timber; owing to the fact that the numerous chemical works there extract from the oil every ingredient that can be utilized, leaving only the residuum for timber preservation. No such difficulty exists here. The oil made in New York and vicinity is equal in quality to the best produced in Europe, has no important ingredients extracted, and can be obtained of any gravity that may be required for creosoting timber.

Messrs. J. G. Moore & Co. have adopted the latest improvements in vacuum and pressure machinery, employ assistants familiar with the process, use only the best qualities of oil, and feel satisfied from the facilities at their command that they can produce results in the treatment of timber, that will, to say the least, fully equal those produced in Europe. They will be happy to furnish gentlemen

interested in the subject of wood preservation with any further information they may require.

Numerous testimonials from gentlemen of well known scientific and practical ability will be found appended, and attention is called to their unqualified endorsement of the Bethell creosoting process.

Communications made either by letter, or in person, at their office, No. 96 WALL STREET, will receive prompt attention.

ABSTRACT OF A PAPER

READ AT THE MEETING OF THE CHEMICAL SECTION AT THE PHILOSOPHICAL SOCIETY AT GLASGOW, BY

MR. P. M. MOIR.

This paper was specially written to explain the methods that have been and are now in use for the preservation of timber from decay by disease and exposure to the atmosphere, or destruction by marine worms and insects.

Timber when exposed to the action of the atmosphere is soon acted upon by damp. This is especially noticeable in all timber fixed in the ground. The action commences at the parts immediately above the surface of the ground, where the fibrous portions of the wood are softened by the moisture, mould and decay being produced. These are indicative of a sort of slow combustion which is set up by the alternations of wet and dry. This kind of wasting away is termed wet rot. Another and very destructive form of decay is termed dry rot. This goes on most rapidly where there is no circulation of air. It is believed by some persons to be caused by parasites; but by others it is believed that the parasites only appear after the decomposition has set in, and that they appear and live to consume the materials which by their accumulation might render the earth and air unsuited to the essential conditions of life and health. There is some probability that dry rot is the result of the felling of timber while it is full of sap, that is, between the end of spring and the beginning of autumn. Another familiar form of disease is that which is

caused by the termite or white ant. This creature's operations prove very destructive in India, Ceylon, Brazil, and most tropical countries. Its attacks are most ravenous on all wood buildings, railway sleepers, and bridges, even though the constructive material be lignum-vitæ, one of the hardest and most durable of woods.

When timber is used in marine structures the destructive agents are greater enemies than decay by dry or wet rot. There are two of them which are the best known among salt water destructive agents, and are very ruinous to all wood erections which are unprotected from their ravages either chemically or mechanically. They are the *teredo navalis*, or ship-worm, and the *limnoria terebrans*. The teredo is a long worm-shaped creature, which perforates timber, generally, in the direction of the grain, but sometimes across the grain with many windings. When a knot is met with or the shell of another teredo, the creature accommodates itself to circumstances by bending from its original course. In a fir pile taken from the old pier of Southend, a worm was found two feet long and three-quarters of an inch in diameter. Some have been seen three and even four feet long, and one inch in diameter. The teredo grows very rapidly, and its ravages are often very terrible on ships, piles, &c. The teredo is not nearly so prevalent on the Scottish coast as in the South of England, and on the coasts of France and Holland, where unprotected timber is readily destroyed.

The *limnoria terebrans* is very abundant around the British shores. Its ravages were first particularly observed in the year 1810, by the late Mr. Robert Stephenson, engineer of the Bell Rock Lighthouse. The limnoria very much resembles a woodlouse, and is about 1-6 inch in

length. It is gregarious, and in situations favorable for the exercise of its habits it soon produces great effects on the wood to which it attaches itself. By boring in all directions it so disintegrates the wood as to allow the sea to wash away its surface, and thus layer after layer of the wood is riddled by the borer, and then abraded by the sea, until the whole piece of timber attached is completely destroyed.

Various opinions have been entertained regarding the mode in which the limnoria perforates and destroys timber, but the opinion expressed by Dr. Coldstream, after very careful observation, seems to be the most worthy of credence. He states that the animal effects its work by the use of its mandibles, and it seems that it is necessary that the hole should be filled with salt water. The distance bored is from one to two inches long, and as the hole increases in size the animal leaves its old workings and begins new ones.

All kinds of timber in the unprepared state, except greenheart, are readily devoured by the limnoria, if used in harbor works not exposed to the influence of fresh or river water. Greenheart is not molested by the animal at all, but every other kind of wood is attacked immediately that it is put into the sea, whether afloat or fixed, but more readily if fixed. The boring is generally limited to that portion which is between two-thirds flood and the bed of the sea or estuary. The rate at which the limnoria bores into wood in pure salt water, is said to be about one inch in a twelve-month; but instances have occurred in which the destruction has been much more rapid. At Greenock, for instance, a pile of twelve inches square was eaten through in seven years. The limnoria

cannot live in fresh water; hence it is not found doing any damage in the Clyde higher than Port-Glasgow.

Greenheart timber in its natural state is the only wood now in use for harbor works that is proof against the attacks of marine creatures, and those of the white ant in tropical countries. There are two reasons why it enjoys this immunity from attack: first, there is its great hardness; and, secondly, there is the presence of a large quantity of essential oil. It is a very hard and durable wood, weighing about 75 lbs. to the cubic foot, and having a specific gravity of 1.089, so that it is a little heavier than water. It is brought from Demerara. Great care is required in working it, as it is very liable to split. In sawing, it is necessary to have all the logs bound tightly with chains, failing which precaution, the log would break up into splinters, and be very apt to injure the men working it.

The author then proceeded to discuss the various mechanical and chemical methods that have been employed to preserve timber from natural decay or from the destruction effected by living creatures. The mechanical methods are wholly employed for marine purposes, and are the oldest in use. One of these consists in covering piles, between high and low-water mark, with flat-headed iron nails, the heads being about one inch in diameter, and the nails being driven so close that the heads touch, but do not overlap each other. This method is expensive, both on account of the materials employed and time required in the operation; and besides this, it is very inefficient, as the nails readily corrode, and leave room for the attacks of the living enemies. Another plan is to cover the piles or other submerged timber with sheets of

zinc or copper. This also is an efficient means of protection.

For the preservation of wood by means of chemical preparations, although many patents have been taken out, not more than six have been worked commercially. In all cases these patents were obtained for the use of solutions of certain chemical compounds, as preservative agents. The names of the patentees and the most valuable compounds employed are shown in the following table:

Kyan	1832	Chloride of mercury.
Margary	1837	Sulphate of copper.
Bethell	1838	Creosote or pitch oil.
Bethell	1848	
Burnett	1838	Chloride of zinc.
Burnett	1840	
Boucherie	1839	Pyrolignite of iron.
Boucherie	1846	Sulphate of copper.
Payne	1841	Sulphate of iron.
Payne	1846	Carbonate of soda.

The methods employed practically in working these patents were three in number, namely; steeping, vital suction, and pressing in close vessels. Kyan and Margary employed the first-mentioned method; Boucherie employed the second; and Payne, Burnett and Bethell employed the third, which was also latterly adopted by Boucherie.

The author described each patented process at some length, mentioning how it is carried out, the advantages and disadvantages in each case, and the conditions under which it has any practical benefit. In no case did the evidence, regarding the value of the process, seem to equal that in favor of the creosoting process, at all events, if the timber is to be exposed to the weather or to be used in structural works, which are subjected to the action of either fresh water or salt water.

Kyanizing, or injecting corrosive sublimate (chloride of mercury) into timber, is very expensive, if properly done; and besides this, there is the fact that it is practically useless, inasmuch as it has been found that kyanized piles, *after three years' immersion in the sea, did not contain a trace of the preservative compound.*

Sulphate of copper, first suggested as a preservative agent by Margary, and afterwards employed largely by Boucherie, may be used to prevent dry rot in timber; but for piers, bridges, railway sleepers, and other structures which are exposed to the action of water, it has no practical value, as the water dissolves out the salt with great rapidity. *Timber prepared with this salt, and used for marine purposes, is as readily destroyed by the teredo and the limnoria as unprepared timber.*

In Payne's process, solution of sulphate of iron is first absorbed into the wood, and afterwards carbonate of soda. Double decomposition ensues, and the practical result is the formation of oxide of iron, the deposition of which renders wood brittle, and does not prevent the attacks of either of the animals just named.

Of Sir William Burnett's chloride of zinc process, the author could say nothing from personal experience. The essential part of the chemical action of the compound is the formation of an insoluble coagulum with the albumen of the wood. It is claimed for the Burnett process that it renders wood proof against the attacks of the white ants in India; and wood for in-door purposes is permanently improved by it.

Bethell's patent process for preserving timber, by the use of creosote pitch oil, is the only one which really accomplishes the object aimed at, although many patents for the

use of oleaginous substances had been secured prior to the year 1838, with the same object in view. Creosote acts very powerfully in coagulating the albumen contained in the cells of the wood, and besides this, it effectually preserves the fibre of the timber, and hence its value over all other so-called preservative agents.

For land purposes, the amount of oil recommended is eight lbs. to the cubic foot of wood, and for marine purposes, from 10 to 12 lbs. per cubic foot. In France, Belgium, and Holland, the quantity used varies from 16 lbs. to 26 lbs. per cubic foot, when the timber is intended for marine works. Beech wood has absorbed as much as 31 lbs. of oil per cubic foot, and when used for railway platforms or harbor works, it is doubtless the cheapest and most durable material that can be used.

Creosote (or pitch oil as it is more commonly called in Scotland) is obtained in the distillation of coal tar, the other ingredients being ammoniacal liquor, crude naphtha, and the residual pitch. The coal tar of Scotch gas works, generally yields about 25 per cent of oil, which distils over at temperatures ranging from 400° to 700° Fahr.; in England, however, the amount is only about 20 per cent. The author estimates the annual yield of pitch oil, in Scotland, at one million gallons, almost the whole of which is used for creosoting purposes. It is probable that creosote owes its valuable antiseptic property to the presence in it of from 5 to 14 per cent of crude carbolic acid, but which could not be used by itself for out-door purposes, as it is slightly soluble in water.

According to Dr. Letheby, creosote acts as a preservative agent in the following ways:

1st. It coagulates albuminous substances and gives

stability to the constituents of the cambium and cellulose of the young wood.

2d. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissues.

3d. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.

4th. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acari, and other parasites.

Since the creosoting process was first introduced in the year 1838, it has been extensively employed in Great Britain and Ireland; in all countries on the Continent where creosote oil can be obtained—France, Holland, Belgium, Germany, Spain, Portugal and Italy; and in India, Cape Colony, Brazil, and other tropical countries, to preserve timber from the attacks of the white ant. Wherever it has been properly carried out, it has been completely successful.

For harbor works, in Scotland, the creosoting process has been largely used. At Leith, the west pier, consisting of 1,013 main piles, is entirely constructed of creosoted timber, and the extension of the east pier contains 312 main piles, also creosoted. These erections were commenced in 1848, and finished in 1853, and at the present time they are as perfectly sound as the first day they were put down. The gates of the new dock now being constructed at that port, are made of creosoted pine, bound with greenheart timber, the quantity of oil used being 10 lbs. per cubic foot. At Port-Glasgow and Greenock, timber prepared by the Bethell process, is largely used, and the same is true of nearly every port of Eng-

land. Much attention has been given to the creosoting process by the Belgian Government, and so satisfactory have the experiments been that no other process is used by that government. Very full and interesting accounts of the Belgian experiments upon the creosoting process, have been prepared by M. L. Crepin, ingenieur des Ponts et Chaussees, especially in "Annalles des Travaux Publics de Belgique," vol. xxi, 1864. M. Crepin affirms that wood retains all its former elasticity in the creosoted state, and acquires a density which it did not possess in the unprepared condition. M. A. Forestier, engineer-in-chief for the department of La Vendee, made a very minute and elaborate report for the Paris Exhibition of 1867, on the creosoting process and experiments made with it on timber used in both land and marine works in France; and in that country the process is also largely employed.

DR. URE, IN HIS "DICTIONARY OF ARTS, MANUFACTURES AND MINES,"

says, in regard to creosoting, that it "consists in impregnating wood throughout with oil of tar and other bituminous matters containing creosote, and also with pyroligneous of iron, which holds more creosote in solution than any other watery menstruum.

"The effect produced is that of perfectly coagulating the albumen in the sap, thus preventing its putrefaction. For the wood that will be much exposed to the weather, and alternately wet and dry, the mere coagulation of the sap is not sufficient; for although the albumen contained in the sap of the wood is the most liable and the first to putrefy, yet the ligneous fibre itself, after it has been

deprived of all sap, will, when exposed in a warm, damp situation, rot and crumble into dust. To preserve wood, therefore, that will be much exposed to the weather, it is not only necessary that the sap should be coagulated, but that the fibres should be protected from moisture, which is effectually done by this process.

"The atmospheric action on wood thus prepared, renders it tougher, and infinitely stronger. A post made of beech, or even of Scotch fir, is rendered more durable, and as strong as one made of the best oak, the bituminous mixture with which all its pores are filled acting as a cement to bind the fibres together in a close, tough mass; and the more porous the wood is, the more durable and tough it becomes, as it imbibes a greater quantity of the bituminous oil, which is proved by its increased weight. The materials which are injected preserve iron and other metals from corrosion; and an iron bolt driven into wood so saturated, remains perfectly sound and free from rust. It also resists the attack of insects; and it has been proved by Mr. Pritchard, at Shoreham Harbor, that the *teredo navalis* (or naval worm) will not touch it.

"Wood thus prepared for sleepers, piles, posts, fencing, etc., is not at all affected by alternate exposure to wet and dry; it requires no painting, and after it has been exposed to the air for some days, it loses every unpleasant smell.

"This process has been adopted by the following eminent engineers, viz: Mr. Robert Stephenson, Mr. Brunel, Mr. Bidder, Mr. Brathwaite, Mr. Buck, Mr. Harris, Mr. Wickstead, Mr. Pritchard and others; and has been used with the greatest success on the Great Western Railway, the Bristol & Exeter Railway, the Manchester & Birmingham Railway, the Northeastern, the Southeastern, the

Stockton & Darlington, and at Shoreham Harbor; and lately, in consequence of the excellent appearance of the prepared sleepers, after three years' exposure to the weather, an order has been issued by Mr. Robert Stephenson that the sleepers hereafter to be used on the London & Birmingham Railway are to be prepared with it before putting down.

* * * * * *

"For railway sleepers it is highly useful, as the commonest Scotch fir sleeper, when thus prepared, will last for centuries. Those which have been in use three years and upward, look much better now than when first laid down, having become harder, more consolidated, and perfectly water-proof; which qualities, combined with that of perfectly resisting the worm, render this process eminently useful for piles, and all other woodwork placed under water.

"Posts for gates or fencing, if prepared in this manner, may be made of Scotch fir, or the cheapest wood that can be obtained, and will not decay like oak posts, which invariably become rotten near the earth after a few years."

EXTRACTS

FROM THE ENCYCLOPÆDIA BRITTANICA.

Eighth Edition.

"Mr. Bethell's method of preparing wood for fences, railway sleepers, piles and other woodwork submerged in water, and for various similar purposes, is said to render timber of any description much tougher, and greatly to promote its durability. It also preserves iron bolts driven into it from

corrosion. Wood thus prepared has been used for sleepers on several of the great English railways, and is said to have proved extremely durable."—Vol. viii. page 213.

"For the preservation of railway sleepers, and other woodwork out of doors, which is not particularly liable to danger from fires, the creosoting process has been found to be most valuable." * * * * *

"This substance seems, firstly, by coagulating the albumen; secondly, by furnishing a waterproof covering to the fibre of the wood; and, thirdly, by preventing the putrefaction of the sap by its antiseptic properties."

"The various processes for the preservation of timber by the absorption of metallic salts have all, more or less, failed in practice, and are now very generally abandoned. * * One great advantage of creosoted timber is that it perfectly resists the attack of marine worms and insects, as well as the white ant of India, which is more than can be said of timber prepared with solutions of metallic salts."—Vol. 21, p. 279.

"Creosote appears to preserve timber with greater certainty than any other chemical material yet used."—Vol. 20, p. 167.

AUTHORITIES ON THE USE OF CREOSOTE OIL IN RAILWAY CONSTRUCTION.

EUROPEAN.

For the past thirty years, crude creosote oil has been extensively employed in Europe in the treatment of railway and dock timbers, as follows:

IN ENGLAND,

Upon the London & Northwestern, Southwestern, Great

Western, Great Eastern, Southeastern, Northeastern, London and Brighton, Lancashire & Yorkshire; Manchester, Sheffield & Lincolnshire; the Taff Vale; London, Chatham & Dover; Midland, Great Northern, Furness Railway, Berwick Railway, Bristol & Exeter, Stockton & Darlington, etc., etc.

IN SCOTLAND,

On the Caledonian, Great Northern, Scottish Northeastern, Edinburgh & Glasgow, North British, Southwestern, Dundee & Perth, etc., etc.

IN IRELAND,

On the Great Southern & Western, the Midland, the Dublin & Drogheda, Dundalk & Enniskillen, etc., etc.

IN BELGIUM,

All sleepers on the State Railway (except oak) are required to be creosoted, *and great care is taken to see that the sleepers absorb a large quantity of the oil.*

IN HOLLAND,

The creosoting process has been adopted to the same extent as in Belgium.

IN GERMANY AND PRUSSIA,

Its use on railways is quite general; and in India, Cape of Good Hope, Brazil, and other tropical countries, it is used to preserve timber from the white ant—and wherever properly used has been *completely successful.* Much of the timber on the above-mentioned railways has been down from twenty-five to thirty years, and is now as sound and free from decay as when first laid down. It is also found to have acquired extraordinary hardness and solidity, and

to have preserved from rust all the surfaces of the iron bolts and fastenings in contact with it.

The average duration of an uncreosoted fir sleeper being less than eight years, it will be seen that many creosoted fir sleepers upon English railways have already outlasted three sets of uncreosoted sleepers, and may yet outlast several more sets. The late Mr. Brunel expressed a confident opinion that well-creosoted fir sleepers would be perfectly sound after the lapse of forty years, and this opinion bids fair to be verified.

FOR MARINE PIERS AND BREAKWATERS,

Creosoting has enabled engineers to use ordinary Baltic timber (similar in character to American hemlock and spruce) freely in these constructions, with the greatest cheapness and absolute confidence in its durability.

THE BREAKWATER AND PIERS

At Holyhead, Portland, Lowestoft, Great Grimsby, Leith, Plymouth, Wisbeach, Southampton, etc., etc., have been built with creosoted timber, and in no case have the *teredo navalis*, *limnoria terrebrans*, or any other marine worms or insects, which rapidly devour unprepared wood, been found to destroy it.

FOR TELEGRAPH POLES,

Mine props, hop poles, and grapevine trellises, creosoted wood has been used with great success.

LETTER FROM MESSRS. JOHN BETHELL & CO., LONDON, ENG.

38 King William street,
London Bridge, E. C., June 11, 1874.

Messrs. J. G. Moore & Co., 96 Wall street, New York:

Gentlemen: As it appears, you have never received ours of January 29th, in which we promptly answered yours of January 9th, we repeat it as follows:

We can put 10 lbs. creosote per cubic foot into yellow pine, and have put 12 lbs. into some red fir, but this is rarely done. The usual quantity injected is 8 lbs for ordinary timber, and for timber exposed to the sea worm 10 lbs. Of white oak we have no experience, but we are creosoting French oak in Belgium and also oak from the Baltic. Into sleepers of such wood we put from 3 to 4 1-2 lbs., sometimes 5 lbs.

We do not mix any substance with the creosote to render it more penetrating; the more fluid it is the easier it is to inject.

It is difficult to judge from such a diagram as you send, of the *exact* amount of penetration of the oil, but approximately we should say that No. 1 of the two is fairly creosoted, and that No. 2 is creosoted about as much as one could expect to creosote oak. It is impossible to drive the oil into the heart of the wood; the sap of the wood is impregnated and a water-proof coating or envelope is thus formed which renders the wood impervious to air and moisture, the oil dissolves the resin of the sap and coagulates with its albumen, and follows in deeper in the course of time to the centre of the wood. It is of great importance that timber once creosoted should not be cut in any way. All timber should be cut to its shape before being creosoted, and all holes and scarfing made before putting the timber into the cylinders.

In practice there is a very great difference between the qualities of creosote oil, some being much easier to work with than others. If thick oil is used it is necessary to use steam to melt it, and even then it is often difficult to force it into the timber. As to preservative properties, we are not aware that there is any marked difference between the various kinds of oil. Some chemists insist upon the oils containing 5 per cent of carbolic

acid (crude tar acids); but, as far as our experience goes, this constituent has very little chemical value as an antiseptic beyond that of other tar oils. Generally speaking the creosote oil we get in London comes from tar produced from Newcastle coal, and is a mass of viscid crystals, only to be got out by steaming or breaking open the cask. On the other hand, oils from Scotland and the Midland and Western Districts of England are very fluid.

With regard to price, creosote is very dear and difficult to obtain since the British Government has definitely adopted the process for its telegraph poles. You would have to pay 5d., f. o. b., Liverpool, per gallon for the 1,500 to 2,000 barrels. We have at present no information as to freight from Liverpool to New York, but if you think you would be disposed to pay anything like that price, we will see what can be done on hearing from you again. We do not quote this as an exact price; creosote is an article liable to great fluctuations, and in a few weeks time little more can be obtained for delivery before autumn.

We have assumed that you do not require any evidence as to the value of creosoting as a preservative. We have lately, since the adoption of the process by all the government and railway engineers, ceased to collect evidence, but we shall always be very happy to send you any which has come in our way.

We are, gentlemen,

Yours faithfully,

JOHN BETHELL & Co.

LANCASHIRE AND YORKSHIRE RAILWAY.

Storekeeper's Office, Miles Platting,
Manchester, February 27, 1874.

D. M. OWEN, *Esq.:*

Dear Sir: The Lancashire and Yorkshire Railway Company commenced creosoting in 1846, and we have now sleepers on our road marked with a X over the end, to distinguish them in future years, that were laid in that year. They have worn well and show no symptoms of decay as yet. I have given this matter my particular attention, and I thoroughly believe in the efficacy of the process, and cause all our timber, such as sleepers, longitudinal and crossing timber, to be so treated. I endeavor to force into the timber 8 to 9 lbs. of creosote per cubic foot, under a pressure, say, of 140 lbs. to the square inch,

continued for three or four hours. I think you had better note, that when the door of our cylinder (which is 75 feet in length and 6 feet in diameter) is closed we exhaust the air and form a vacuum. We then open a valve, and the reservoir being underneath, the creosote rushes up into the cylinder and nearly half fills it. It takes up a little air in the action, and we then put on our force pumps and fill it, and continue till it blows off at the safety valve a stream as large as a man's wrist, which lasts the length of time previously named. This, with Baltic or American red timber, should cause the sleeper to absorb 27 to 30 lbs. of creosote. Size of sleeper, three-and-a-quarter cubic feet. Sappy timber will absorb more than heart, but is equally durable and will not decay.

I have followed this practice in longitudinal and buffer timber, piles for wharves, etc., and if the timber is in very large squares I get my joiner to bore a hole in the pipe of the wood, at the end, say two feet or more, to allow the creosote to force its way to the interior of the timber, and I have never known, up to the present time, any to fail.

You stated that your friends expect that we should force the creosote through and through. This cannot be done, *and is not necessary;* but after a piece of timber has been tanked, cross-cut it, say a foot from the end, and place it in the hot sun for a few days. You will then see how far the lighter parts of the creosote have filtered towards the centre.

I should say, from experience, that there is no fear of any decay, as nothing can live near it. I have frequently noticed, when our platelayers have thrown off black sleepers into the water courses or drains that all life has been destroyed, and frogs, worms, and insects of all kinds, might be seen dead in the water.

If your people wish to have the timber more thoroughly impregnated you will require to continue the pressure much longer than I have named, which will, of course, make it more expensive.

For your information, I may state that this company have tanked, under my superintendence, over 1,500,000 sleepers, besides longitudinal and crossing timber, and if the process has only prolonged the life of the timber by one-half, I think I have saved the company a considerable amount of money.

When at my office you stated that you would like to have one of the paving blocks that I had that day taken up out of the floor of our turning shop, and which had been there, exposed to both wet and dry, under the lathes and grindstones for 26 years. This you can have with pleasure, and it will give your friends a very good idea of the use and value of creosote. I will also send you a piece of a sleeper, cut from some still in

use in our long tunnel, and which are reported by our engineer to be sound and good, although they have been in the road 26 years.

If you will write to me and state by what conveyance you would like to have the two samples sent to America, I will forward them with great pleasure, and hope that they may be of service to you and railways generally.

Trusting that this information may be what you require and to your satisfaction.

I remain, dear sir, yours very sincerely,

R. J. BADGE.

Mechanical Engineer and Storekeeper Lancashire and Yorkshire Railway Co.

MIDLAND GREAT WESTERN RAILWAY, OF IRELAND.

Permanent Way and Royal Canal Departments,
Engineers' Offices, Broad Stone Station,
Dublin, February 19, 1874.

D. M. OWEN, Esq., Gresham Hotel, Dublin:

Dear Sir: Relative to your inquiries as to the merits of creosoted timber, I would state for your information the result of my experience of very many years, and upon different railways in this country. The object of the creosoting process is to impregnate the pores of the sap-wood of those timbers which have naturally enduring heart-wood, such as the *pinus sylvestus*, from whence our memel timber is derived, and oak. The pores of the heart-wood are charged either with resin or other preservatives, which prevent the admission of the creosote, and indeed render it unnecessary; other timbers such as beech and silver fir are all through of the nature of sap-wood, and will take up a large quantity of creosote. as all the pores have to be filled.

In creosoting timber so as to be effective, the points to be attended to are as follow: Cut, shape and bore your timber first, then the pores having been emptied by exhaustion, force in as much creosote as will fill them. Afterward let the timber be stacked for sufficient time to allow the creosote to combine with the timber, and thoroughly harden. My experience in railway sleepers thus prepared is, that decay which commences

in the sap-wood and infects the heart-wood is entirely prevented, and the timber lasts at least twice as long as if unprepared. I use a moderately black oil. Believe me,

Yours faithfully,

JAMES PRICE, *Chief-Enginer.*

STONY ROAD CREOSOTING WORKS.

Dublin, February 20, 1874.

D. M. OWEN, Esq.:

Dear Sir: With reference to your inquiries as regards creosoting railway sleepers my experience is that from 7 to 8 lbs. to the cubic foot of wood is all that is required of oil, and is all that is exacted by the railway companies here. This quantity will thoroughly creosote the sap-wood when the lighter kinds of oil are used. We are now working for the Dublin & Drogheda Railway. I shall be happy to show you the process we adopt should you call upon me.

Very truly yours,

JOHN BERRY, *Civil Engineer.*

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22 Eden Quay, Dublin, February 20, 1874.

Dear Sir: The quantity of oil we are required by the engineers of the Dublin & Drogheda Railway to use is,

7¼ lbs. per cubic foot for half-round 10 x 5 sleepers.
6¼ " " " half-square 12 x 6 "

This impregnates and dissolves the sap-wood, and its influence extends in a more modified way to the heart-wood. Sleepers prepared in this way resist the effects of climate and are not subject to decay. The sleepers are of red-wood (*pinus sylvestus*) from the Baltic, chiefly from Russia and Prussia, and are 9 feet in length.

Yours faithfully,

PATRICK MASON.

D. M. OWEN, Esq., New York.

Blue Pits, Manchester, March 2, 1874.

D. M. OWEN, Esq., Langham Hotel, London:

Dear Sir: In answer to yours of the 27th ult. I would state that my experience in creosoting timber for railway purposes, bridge timbers, etc., dates from 1864, and my experience convinces me of the great benefit derived from the use of the process. We have on our road at the present time some sleepers which were creosoted in 1848 which are to-day as sound as when first put in the road. The effect seems to be to impregnate the pores of the sap-wood or the outward formation of the timber, and by preventing decay in that portion of the wood (from whence it would otherwise proceed), preserve the whole of the timber. In answer to your inquiry as to whether decay would not be likely to commence in the heart-wood or the unimpregnated portion of the treated wood, and internal rot result, I would state as the result of my experience that decay does not *commence* in heart-wood; that it proceeds from the sap-wood, and that the contaminating influence of the latter is what occasions the rotting of timber. In case the heart-wood is affected by decay before the creosoting process is applied, the oil, as will be readily seen, would easily penetrate to the infected spot and prevent its further spread on account of the timber being much less firm in texture wherever decay has commenced. I get in the timber which I creosote from 5 to 10 lbs. of oil per cubic foot, the quantity varying more or less in proportion as the timber is more or less porous. The proper method of applying the oil is to enclose the timber in an air-tight iron tank, made strong enough to withstand a pressure of from 120 to 140 lbs. per square inch; then to obtain a vacuum by pumping the air from the tank, and finally admitting the oil slightly warmed, and applying the pressure mentioned above by force pump. The effect will be to impregnate the wood to a depth varying from one to three inches, as can be seen by boring, or to a depth equal to that of the sappy formation of the timber. In the course of time the oil penetrates more deeply in the wood, sometimes reaching the centre. Any further information you may require on this subject I will be happy to give you.

Very truly yours,

HENRY GEE,

Superintendent of Creosoting Works,

Lancashire & Yorkshire Railway,

Blue Pits, Manchester.

CHICAGO, BURLINGTON AND QUINCY RAILROAD.

Car and Building Department,
Superintendent's Office, Aurora, June 5, 1874.

R. HARRIS, Esq., General Superintendent:

THE first platforms laid with plank treated with dead oil were at Montgomery and Oswego, five years ago last winter. They appear to be as sound as when first laid.

We also extended the platforms at Galra and Leland the summer following, which are also in good condition.

There were also a lot of ties put in the Aurora yard six years ago last fall, which are as sound as the day they were laid.

From these experiments, I am satisfied that the dead oil treatment is a pretty sure preventive against decay.

Yours truly,

W. W. WILCOX.

CHICAGO, BURLINGTON AND QUINCY RAILROAD.

Car and Building Department,
Aurora, October 6, 1874.

PAGE, KIDDER & FLETCHER, New York:

GENTS: The planks for the platforms referred to in my letter of June 5th, were white pine. We also treated quite a large quantity of yellow Norway pine for car flooring. The ties treated were principally hemlock. There were also quite a quantity of oak ties treated.

Yours truly,

W. W. WILCOX.

LETTER FROM MR. G. S. PAGE, OF NEW YORK,

Giving Results of his Observation and Information obtained recently in Europe.

New York, May 28, 1870.

SIR: In reply to your inquiries concerning the preservation of wood in Europe, I beg to say that one of the principal objects of my recent trip abroad was to obtain full and accurate information upon this most important subject.

My investigations were conducted in England, Scotland,

Ireland, France, Belgium, Prussia, Russia, and Austria, and were continued for nearly four months.

I found that but three processes have ever met with any favor or been used to any extent, viz.: Kyanizing, Burnettizing, and Creosoting. The first named is the term applied to the injection into the pores of the wood of a solution of corrosive sublimate; the second is a similar use of chloride of zinc, and the latter is the application of crude creosote oil or the heavy oil of coal tar. With but a single exception, I found that the material now universally used was crude creosote oil, it having been proved to be a perfect preventive of decay and the only material that fully accomplishes that result.

The principal uses to which creosoting was applied were for railroad ties, telegraph and hop poles, fencing, piles and dock timber, and lumber used in coal and iron mines.

On several of the roads I traveled over, I found creosoted ties were already over twenty years in use, and still sound as when first laid.

Baltic fir—a timber resembling American hemlock—is generally employed for ties in Europe. When creosoted, it lasts without decay as above stated; while, uncreosoted, it decays in from three to four years.

The spikes driven into these creosoted ties show no corrosion whatever after this lapse of time, and the rail is consequently held more firmly to the tie.

I found the density of the wood much increased by the action of the oil, the fir ties acquiring almost the density of our oak.

The use of these creosoted Baltic ties is almost universal upon the following, among other roads, which I observed, many of which have a heavier and more constant traffic than the average of American railroads, viz.: Lancashire & Yorkshire; London & Northwestern; London, Chatham & Dover; Midland; Dublin & Drogheda: Midland Great Western, of Ireland; Great Southern, of Ireland; Great Northern, of France; and the railways composing the lines from Paris to St. Petersburg, via Cologne and Berlin; Berlin to Vienna, via Dresden and Prague; Vienna to Paris, via Munich and Strasbourg; and Paris to Brussels.

Creosote oil, in the treatment of wood, was first employed in 1838, and has grown rapidly in favor until, at the present day, it is adopted all over Europe, and is recommended by the most eminent engineers and scientific men. Indeed, creosoted timber is the rule in railroad construction, and native wood the exception.

The next use in importance of creosoted wood was in the construction of piers, docks, breakwaters, etc.; and here it is

found to be the only infallible protection against the ravages of the *teredo navalis*, that dreaded marine worm.

Piles sheathed with copper and iron, or studded with flat nails, have been employed from time to time in marine works; but even those costly means have been found to be no safeguard against the worm. But creosoted timber has so perfectly answered its purpose that it is now exclusively employed in works of this character. Marine worms of all kinds fail to make the least impression upon it. It is a poison to them, and at the same time the wood neither checks nor decays above water.

My observation on this class of structures was quite extensive; and in no case has properly creosoted wood, so employed, failed to give complete satisfaction.

The usual quantity of creosote oil required in marine structures is from six to nine pounds per cubic foot.

My extended observation abroad, of the actual results of creosoting wood, and the experience of engineers with whom I have communicated, has satisfied me that this subject has passed out of the region of theory and experiment, and is now a practical fact. Creosote oil is the only efficient material to accomplish the result, and is actually the only one used in operations of any importance.

I send you herewith some sections of railway ties, by which you will see the sound condition of creosoted wood after twenty-three years' service. They are average specimens. I also send copies of some letters I have received from Mr. Badge and others, upon this subject, which but express the opinion of the leading railway managers whom I met.

I must say, in conclusion, that an experience so thorough and exhaustive, with results so satisfactory, should be accepted as sufficient, and that we should await for no similar experiments here to convince us of the economy, as well as practicability, of preserving our timber by the use of cresote oil.

Yours, etc.,

GEORGE SHEPARD PAGE.

YORKSHIRE AND LANCASHIRE RAILWAY.

Manchester, August 14, 1865.

Dear Sir: I commenced creosoting timber in 1846, and for some months marked the ends of the sleepers with a V

tool. Some thousands were so done in order that I might the more readily watch them, and trace the result.*

Last month I visited a portion of the line which had been laid with these sleepers in 1846, and I am glad to be able to report that the whole are as *fresh and sound as when first laid down, not the least signs of decay being apparent.*

During a period extending over upwards of nineteen years I have creosoted about one million of sleepers, and large quantities of timber of various kinds, and from all my experience, gained during that time, I would strongly recommend to be creosoted all timber to be placed in exposed situations, such as sleepers, telegraph posts, lamp posts, fencing, etc.

I remain, dear sir, yours very truly,

R. J. BADGE.

P. S.—The creosoted road generally wears out three or four sets of rails in, as well as out of, tunnels; and when the main line is relaid, and such sleepers are taken out, they are used again for sidings and branches. I find that about one per cent get split at the ends, and so rendered useless for their original purpose, but they are then sold for gate posts, fencing, etc., and are much sought after.

Storekeeper's Office, Manchester, Feb. 3, 1870.

G. S. PAGE, Esq.:

Dear Sir: In accordance with my promise, I have sent you a small hamper, containing three or four sample ends of creosoted sleepers, which were tanked under my superintendence in the year 1846. I have sent you two ends marked with a X, thus—one shows the solid heart of the wood; the larger one shows a proportion of sap, which is equally well preserved as the hearty one. Note that sappy timber takes much more creosote than the heart, or solid timber, on account of the pores of the wood being more open. The two unmarked pieces is the next cut to the one with a X, to enable you to see what a pressure can effect by filling the pores. I should recommend ten pounds per cubic foot to each sleeper—that is, if the sleeper is three feet, there should be three gallons in each. I do not think I have anything more that I can communicate to you at present, but I may remark that some three years ago some of the leading lines discontinued creosoting. I

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*These sleepers are now in use and perfectly sound, as will be seen by the letter which follows. Sections of these sleepers, which are also referred to in Mr. Badge's letter of February 3, 1870, can be seen at our offices.

have just received a letter, stating that some of the uncreosoted sleepers that had been recently laid are showing strong symptoms of decay, and I believe Mr. Bethell's orders are becoming pressing. I believe that all our railway companies will see the great benefit that must arise from the use of creosote. Should you require any further information, you can write to me, and I shall be most happy to afford it at any time.

Yours very truly,

R. J. BADGE.

Manchester, Eng., Feb. 24, 1874.

Messrs. PAGE, KIDDER & FLETCHER, New York:

GENTLEMEN: We have just cut pieces from sleepers of those on the down line of the Summit Tunnel, which were laid *twenty-six* (26) *years ago* next Christmas; the pieces are sound, hard and as fresh as when laid, and all are in the same condition.

There is a great advantage in creosoting timber for sleepers, in the fact that iron spikes do not corrode or rust, and I believe the fibre of the timber is strengthened by the process. Sleepers, after being in use for many years, are worn only by the chairs—all such I am selling in large quantities to colliery proprietors and others for sidings and fences, for fronts of stations, drains and many other purposes, at 2s. and 2s. 3d. each. They are much sought after and scarce. We may almost say there is no end to them, unless they are burned. I have superintended the creosoting of over *one million five hundred thousand* sleepers, besides longitudinal and crossing timbers; these timbers will resist worms, wind or rain, and lie, like a brick, not subject to decay.

I took up a couple of paving blocks, that have been in our turning shop under grindstones and lathes, exposed to wet and dry for *twenty-six years:* they are in perfect condition, showing no signs of decay.

Respectfully,

R. J. BADGE,

Mechanical Engineer Lancashire & Yorkshire Railway.

MIDLAND AND GREAT WESTERN RAILWAY OF IRELAND.

Engineer's Office, January 8, 1870.

Dear Sir: In reply to your inquiries as to my experience of the practice of creosoting sleepers, I beg to state that I have

seen this mode of preparation in use for the last fourteen years, and that I have employed it myself on the railways under my charge for the last nine years, and that I am now using it extensively in the renewal and repairs of this system of railways, having a mileage of nearly four hundred miles. We have purchased sixty thousand sleepers of red Baltic fir, creosoted according to the specifications within, during the past year. My opinion is, that all timber having sap-wood to any extent, requires this process; the sap-wood is thus converted into a hard waterproof covering instead of a decomposing mass;—in the former case, the heart-wood is protected; in the latter, decay is favored. I have seen home-grown timber of soft fir and chestnut, which had been down for over ten years, so hard and compact on the surface that a knife could not penetrate it, and I believe the sleepers I then saw will last ten years longer. I have never yet seen on any railway in Ireland (several of which I have been employed to report on) a single decayed creosoted sleeper. Where timber contains no sap-wood (unless spruce, other white deals, and beech, all of which require creosoting), such as memel or hard larch, grown on stony ground, it is unnecessary to use creosote; the oil will not enter the pores already filled with resin. With the timber under proper pressure, the oil will penetrate longitudinally the whole ring of sap-wood—so that it will be found in the centre of the length of the sleeper, as well as at the ends. A sleeper, with a ring of one and a half inches of sap-wood, will take up from seven to ten pounds of oil per cubic foot of timber (counting heart and sap).

Believe me, dear sir,

Yours faithfully,

JAMES PRICE.

To G. S. PAGE, Esq., New York.

DUBLIN AND DROGHEDA RAILWAY.

Engineer's Department, Dublin, Jan. 7, 1870.

GEORGE S. PAGE, Esq., Shelbourne Hotel:

Dear Sir: The sleepers used on this line for nine years are almost exclusively red-wood, from the Baltic, either 12x6 or 10x5, and nine feet long. For about the last six or seven years, all have been creosoted with not less than seven pounds of oil, and commonly much more, to the cubic foot. I have not yet found in the line an unsound creosoted sleeper that I had not reason to know was unsound before being creosoted; and even in such a case, the creosoting seemed to have the

effect of stopping the decay. The cost at present to us of creosoting is one shilling per sleeper for joints (12 x 6), and eight pence half-penny per sleeper (10 x 5) for middles. Lines that can rot out their sleepers, such as this, have great advantage from creosoting; but there are lines, the rails of which, from being unsteady on the sleeper, chafe them, to whom creosote is of no value, because their sleepers wear out instead of lasting long enough to rot. I send you a pamphlet sent to me years ago by Mr. Bethell, which you may find useful.

Yours very truly,

MARCUS HARTY.

LONDON AND NORTHWESTERN RAILWAY.

Permanent Way Department,
Head Office, Stafford, July 17, 1856.

Sir: In answer to your letter requesting information (for the use of the Commissioners of the Exposition about to be opened at Brussels) as to the success of your creosoting process in preserving railway sleepers, I have to inform you that about seventeen miles of the railway from Manchester to Crewe, belonging to this company, are laid with creosoted American fir sleepers. Part of these were laid in 1840, and the rest in 1842, since which time we have not had one instance in which decay has been detected in these creosoted sleepers; and upon our relaying the line, we have used over again all the old creosoted sleepers that were not split, instead of new sleepers.

Yours truly,

HENRY WOODHOUSE.

BRISTOL AND EXETER RAILWAY.

Bridgewater, August 28, 1856.

Sir: I have, for the last seven to eight years, been constantly engaged as superintendent over the carpenters employed in keeping in repair the wood bridges on the Bristol & Exeter Railway.

In many of these bridges, a great deal of your creosoted timber was used, which has been in use now upward of fourteen years, and I can testify that every piece of creosoted wood in them is now perfectly sound and free from decay.

Your obedient servant,

JOHN DYER.

GREAT EASTERN RAILWAY.

Great Eastern Railway, July 16, 1856.

Sir: I have been fourteen years engaged in superintending the permanent way of the Eastern Counties Railway, near Burnt Mill Station, and have during the whole of that time constantly observed the creosoted Scotch fir sleepers laid down there in May, 1840.

I can fully testify that the whole of those sleepers are now as sound and perfect as when laid down, and the creosote oil seems as fresh in them now as ever.

I have sent you herewith some specimens of those sleepers, and all the sleepers are as good as these specimens.

I am, sir, your obedient servant,

SAMUEL DAWSON.

DUTCH-RHENISH RAILWAY.

Driebergen, April 4, 1858.

Sir: In answer to your inquiry relative to the timber prepared according to your process, the so-called "Creosoting Process," I beg to inform you that in the year 1844, during the construction of our line, 10,561 cubic metres of timber were creosoted at Utrecht, and laid between Utrecht and Veenendaal, the oil for which, distilled and delivered by you, has proved of the best quality.

In 1855–57, with the extension of our line to Germany, in connection with the Cologne & Minden Railway, and consequent alteration to the narrow gauge, the timber creosoted and laid in 1844 was taken up and found as sound and perfect as when first laid, and consequently used over again, while uncreosoted timber close by has been obliged to be renewed two or three times during the same period.

We fully expect the same favorable result from the timber required for our extensive works in course of construction at Rotterdam, now creosoting, and during the past year creosoted at your creosoting establishment at Fijnord, Rotterdam.

I remain, sir, your obedient servant,

G. FREEM,

Chief Inspector Dutch-Rhenish Railway.

COLOGNE & MINDEN RAILWAY.

Hitherto it has not been necessary to renew any of the sleepers or timbers used in bridges that were impregnated with creosote oil, the sleepers that were laid down in 1849 being in as good condition as ever. On the Dutch railways, also, creosoted sleepers have proved very durable for twelve years, and creosoted timber has been employed there also for water works.—*Eisenbahnzeitung*, No. 29, 1857.

PUBLIC WORKS IN BELGIUM.

In the report presented by the Minister of Public Works in Belgium, in May, 1863, to the Legislative Assembly, respecting the operations of the State railways in the year 1862, it is stated as follows:

Page 12.—"In 1862 a special commission was instituted to determine the state of preservation of the sleepers which, before being put into use, have been the object of preparations destined to prolong their duration. The result of this commission has been to persuade the Government to give up entirely the process Boucherie, and for the future to abide by the using—1st, of oak sleepers in their natural state, or which have been submitted to the preparation of the creosote oils; 2d, of beech sleepers, or red pine, prepared after the same process."

In the spring of 1865 a very careful examination was made by the authorities of all the creosoted sleepers, and they found that all these sleepers (although some of them had been in use nineteen years) were perfectly sound and fresh, and in consequence the Belgian Government decided to have all their sleepers creosoted in future.

LONDON INSTITUTE OF CIVIL ENGINEERS.

At a meeting of the Institute of Civil Engineers in London, in May, 1850, Mr. Brunel and Mr. Hawkshaw, the eminent engineers, remarked as follows:

Mr. Brunel believed that longitudinal timbers, thoroughly creosoted and properly put together, were at least as durable as the iron rails; and he might even say that, under certain circumstances, the timber would last the longest. He believed that, with fair usage, the timber would be more durable than the iron, so that he did not agree in the desirability of abandoning timber and adopting iron for sleepers.

He must expressly state his convictions, that, at the expiration of *forty years*, well-creosoted longitudinal timbers would be found in a sound and serviceable condition.

Mr. Hawkshaw had arrived at the conclusion that well-creosoted longitudinal timber sleepers, with heavy malleable iron rails, formed the best and most durable line: it was the cheapest in the first cost and in subsequent maintenance, and was least injurious to the rolling stock. —*Institution of Civil Engineers' Minutes*, Vol. ix, pp. 403–5.

At a meeting on January 11, 1853—

Mr. Hawkshaw said he had tried all the principal systems, and would not generally adopt any except creosoting. Kyan's was inefficient, Burnett's was not satisfactory, and Payne's rendered the wood brittle. He had certainly never seen an instance of decay in creosoted timber, even in the most unfavorable position.—*Institution of Civil Engineers' Minutes*, Vol. xii, p. 230.

Statements made before the London Institute of Civil Engineers, and reported in the *Civil Engineer and Architect's Journal:*

"The creosoting process was not, as often described, a chemical process entirely. It was to a certain extent, because the creosote oil was the strongest coagulator of the albumen in the sap of the wood. But that was not his only idea when he introduced the process; his object was also to fill the pores of the wood with a bituminous asphaltic substance which rendered it water-proof, and by which, in process of time, the wood so treated became much more solid and harder than heart-wood itself.

"The result was fully shown by some specimens he had received from Belgium of half-round sleepers creosoted by him fifteen years ago, which showed that all the young wood had become set, as it were, into a piece of solid asphalt; and Scotch fir and Baltic timber which had their pores filled with the tar oil, became entirely water-proof. Of the Scotch fir sleepers laid on the Northeastern Railway in 1841, eighty per cent are doing duty at the present time, and such cases of decay as have occurred were found to have taken place in the heart-wood. The engineer of the Belgian State Railways had sent him some specimens, not long ago, which illustrated the same fact. He found one specimen which had lost a piece of its heart by decay; but upon experimenting upon the transverse strength of that sleeper, against a similar sleeper uncreosoted, it was found quite as strong, though it had lost its heart, because, from the thorough impregnation of the bitumen, the young wood had become so hard that it was more like an iron pipe, and he was satisfied that if

it lost all the heart it would be stronger than a sleeper in its natural state.

"The half-round sleepers lasted longer than the square form, because they retained all the young wood, and would have more creosote in it, but in the square sleeper it would be cut off."

SOUTH DURHAM COLLIERY.

South Durham Colliery, March 5, 1859.

Dear Sir: I beg to state in reply to your note, that the creosoted props put in in February, 1844, are still standing, and, to all appearance, are as sound as when put in 15 years ago. We put in props of the same sort of the timber, uncreosoted, in the same place, which do not last more than from six to nine months, until they are to renew.

I am, dear sir, yours truly,

ADAM HACKWORTH, *Overman.*

STOCKTON AND DARLINGTON RAILWAY.

March 15, 1867.

GENTLEMEN: I forwarded per rail, yesterday, a piece of creosoted yellow pine timber, cut from the end of a sleeper, which was laid down on the Stockton & Darlington Railway, August, 1841.

The sleeper, save being slightly indented by the chairs, is in a state of excellent preservation, and likely to last many more years.

You will perceive that the piece forwarded is as sound and strong as the first day it was laid in the ground, nearly twenty-six years ago. It would have been rendered useless in quarter the time if laid down in its natural state.

Now, seeing that the decay of timber is gradual, and goes on from year to year, and the creosoted timber is unchanged after twenty-six years, one cannot put any limit to its duration, save from mechanical action, such as that of small based-chairs; the careless and injudicious manner in which they are fastened to the sleepers in many cases suffering them to work loose for long periods, and thereby embed themselves. These are causes which I believe have never received a sufficient amount of

attention, but which can, in a great measure, be remedied; and, no doubt, have often given a bias against creosoting.

I believe I may safely say that I have had now as large an experience in permanent way as most men (something like forty years) and have had to do with stone blocks. different kinds of timber laid down in its natural state. and cast-iron sleepers, which, by the way, I have seen taken up after being down some seven or eight years, half eaten away by the sulpher from the ballast, and do think that *properly creosoted* traverse sleepers of *good substance*, chairs with a good base and *properly fastened*, and double-headed rail 75 or 80 lbs. per yard, seated on oak cushions, make the best and most economical permanent way that has come within my experience.

I am, gentlemen, yours respectfully,

THOMAS SUMMERSON, *Inspector.*

Hope Town Foundry, Darlington,
April 17, 1867.

GENTLEMEN: I have been making some tests of creosoted and uncreosoted Scotch fir and memel timber for Mr. Cudworth, of the S. & D. Railway. It appears that an impression has got abroad, that creosoting renders the timber short or brittle; however, the result of our test proves quite the contrary. We took six pieces each of creosoted and uncreosoted Scotch fir, 2 ft. 6 in. by 2 ft. 1 1-2 in., cut from the heart of the same sleeper and the same quantity of memel; the average breaking weight, both as regards the Scotch fir and memel, was in favor of the creosoted timber. This nearly agrees with some tests I made from the pieces of timber I sent you last, and which had lain twenty-six years. I thought if there was any deterioration of strength it was the most likely to be from this, which was yellow pine. I took six pieces from it 5-8 in. square, and six pieces of the same substance from a new yellow pine deal, and tested these with an indicated spring balance and found the strength as nearly equal as possible, but there was a marked difference in the deflection or yielding previous to breaking, the creosoted timber bending much more than the other. I don't know whether you may have made any trials yourselves. I was curious in the matter myself, and thought it might be interesting to you.

I am gentlemen, yours respectfully,

THOMAS SUMMERSON.

TANFIELD MOOR COLLIERY.

Newcastle-on-Tyne, May 6, 1867.

GENTLEMEN: We put in a quantity of your creosoted props in the main return air-course in the Tanfield Moor Colliery, in April, 1860; at the same time we put in an equal quantity of larch props, alternately; the larch were renewed twice in three years, when we replaced them with creosoted props from your establishment, the whole of which appear to be as sound as when first put in. We send you a portion of one of the props put in in 1860.

We are, gentlemen, yours respectfully,

JAMES JOICEY & Co.

MICKLEY COLLIERY.

Mickley Colliery, June 28, 1867.

GENTLEMEN: Creosoted timber was used for securing the horse and engine ways of Mickley Colliery about fourteen years ago; the accompanying samples show the condition of the timber; in similar places in this colliery, larch timber will continue sound for about six years, and Scotch for about four years. I therefore have much pleasure in bearing testimony to the advantage of using (where practicable) creosoted wood for timbering the permanent roads of a colliery.

I remain, gentlemen, yours truly,

MATTHEW LIDDELL.

EXTRACTS FROM THE BUILDING NEWS OF JULY 5, 1870.

"The preservative properties of creosote appear to be threefold. First, it prevents the absorption of moisture in any form or under any change of temperature; secondly, it is noxious to animal and vegetable life, thereby repelling the attacks of insects, and preventing the propagation of fungi; thirdly, it arrests the vegetation or living principle of the tree, after its separation from the root, which is one of the primary causes of dry rot and other species of decay.

"Creosoted sleepers (American white fir) placed on the line from Manchester to Crewe, in 1838, are still as sound as when first laid down.

"Creosoting, too, has proved most effective against marine worms, according to E. H. Von Baumhauer, who was engaged

by the Royal Academy of Sciences at Amsterdam, to investigate the subject, and who proved to the society, in a manner incontestible, that the *teredo navalis* had never attacked wood that had been thoroughly creosoted.*

"It has been stated that creosoting renders timber brittle, but no satisfactory proof has yet been adduced; while, on the other hand, we have the testimony of such gentlemen as Mr. Ure, the engineer of the River Tyne Commissioners, who gives it as his opinion that there is no difference between the strength of creosoted and uncreosoted timber; as for long beams, diagonal stays, etc., he specifies the same sizes in both cases; and further, that, in driving some long piles, they had driven them so hardly that they took fire at the top, and yet showed no signs of breaking. Mr. Ure, as most engineers know, has had very large experience in pile-driving.

"Mr. Burt states that, after an experience of twenty years, during which time he sent about one million and a half of sleepers to India alone, besides having prepared many thousand loads of timber for other purposes, he could safely assert that the instances of failure had been rare and isolated. In those cases where decay had taken place, it has been found, on inquiry, to be due to the operation not having been properly performed. As a collateral proof that this mode of preserving timber is considered satisfactory, it has lately been more extensively employed than any other method."

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* See "Sur le Taret et le moyens de preserver le Bois de ses degats." Par E. H. Von Baumhauer. 1866.

AUTHORITIES ON MARINE WORKS.

REPORT UPON EXPERIMENTS

OF MONS. L. CREPIN, INGENIEUR DES PONTS ET CHAUSSEES, UPON CREOSOTED BALTIC TIMBER, TO TEST ITS POWER OF RESISTING DECAY, AND THE ATTACKS OF THE TEREDO NAVALIS IN SEA WORKS.

ANNALES DES TRAVAUX PUBLICS DE BELGIQUE.
VOL. XXI. 1864.

The experiments undertaken by me in 1857, at Ostend, to ascertain the relative preservation of timber prepared with sulphate of copper, and timber prepared with creosote oil, when placed in the sea, and the relative resistance of such differently-prepared timber to the attacks of the teredo worm, were described in volumes 19 and 20 of these Annales.

I having proceeded with these experiments, and having again minutely inspected the creosoted wood, I am able to say that it presents no trace of the teredo, and is in a perfect state of preservation. The experiments, I believe, may be now taken as decisive, and we may conclude that well creosoted fir timber, prepared with creosote oil of good quality, is proof against the attacks of the teredo, and is certain to last for a long time.

Let us sum up the results of these experiments, or, at least, such as apply to the timber submerged in the sea,

and exposed to the teredo's attacks. This timber is placed exactly 6 ft. 3 in. (1.90 met.) above the low-water mark of spring tides, so that the pieces between 6 ft. 7 in. and 8 ft. 7 in. (2 met. and 2.60 met.) long are left partly dry twice in the day. The teredo greatly abounds at Ostend, and has been found in all situations below 6 ft. 3 in. (1.90 met.) above the low water mark of spring tides.

In the first fortnight of the month of October, 1857, I placed immediately beneath the line marking 6 ft. 3 in. (1.90 met.) above the water mark, upon the piles of the east pier—

1. Three pieces of creosoted fir, which had been taken from a lot of wood prepared in the ordinary way by the State Railway.

2. Three pieces of beech prepared with sulphate of copper.

3. One piece of fir and one piece of beech wood not prepared in any way.

THE FIRST INSPECTION, 1859.

In the beginning of January, 1859, the above mentioned pieces were taken down and inspected.

It was found that the piece of fir unprepared was much perforated by the teredo; that the piece of beech unprepared was perforated from one end to the other; that the pieces prepared with sulphate of copper were all three eaten by the teredo; and that the three pieces of creosoted fir alone were intact, and without a trace of the teredo.

The three last-mentioned pieces alone were replaced, a slice having been previously cut off from each as a specimen; in two of the pieces the sawn surface was covered

with flat-headed nails; but, in the case of the third, this precaution was purposely omitted.

THE SECOND INSPECTION, 1860.

The second inspection of the three pieces of creosoted wood took place in March, 1860.

Traces of the teredo were discoverable in the piece, the sawn surface of which had not been covered with the flat-headed nails; but the two other pieces were altogether intact. Upon the heart-wood portion of one of the sides which probably had not been very fully impregnated with creosote, some very small holes of young teredos were discovered, but it was plain that they had not been able to penetrate it at all. The two latter pieces were replaced.

THE THIRD EXAMINATION, 1862.

In the early part of July, 1862, the two pieces replaced in 1860 were re-examined, and presented no signs of the teredo. They were then replaced as before.

THE FOURTH EXAMINATION, 1864.

The two pieces replaced in 1862 were examined upon January 21, 1864, and it was then found that they presented no trace of the teredo, and no signs of decay of any kind. These two pieces are now in as perfect a state of preservation as when they were first put into the sea; the wood has retained all its elasticity, and has acquired a density which it did not possess in its unprepared state; the creosote oil also appears to have been entering more deeply into the wood. These two pieces have been exposed to the teredo from the month of October, 1857, to 21st January, 1864—a period of more than six years.

They had, however, absorbed but a small proportion of creosote oil. They are now in a state of perfect preservation. The experiment appears to me conclusive.

However, as I said in the notice of this experiment, inserted in volume 20 of the Annales, the Honorable the Minister of Public Works was so good as to order some pieces of wood to be prepared at Ghent on the 16th May, 1861, by the officers of the State Railway, expressly for my use; and I accordingly received fifteen pieces then prepared, with which to make a further experiment. I fixed these fifteen pieces, in the first fortnight of June, 1861, upon the front row of piles of the east pier, all within 6 ft. 3 in. (1.90 met.) above the low water mark of the spring tides.

In the course of the winter of 1861, and the first month of 1862, three of these pieces—numbered 30, 33, and 40—were swept away by the sea and lost.

The remaining twelve pieces were taken off, placed on the quay, and examined on the 11th of July, 1862. After having ascertained that they bore no trace of the teredo, I kept, as samples, numbers 16 and 18, and replaced the ten others.

These were taken down and examined on 21st of January, 1864, and it was then again ascertained that they showed no trace of the teredo, nor any kind of alteration or decay.

They are strongly impregnated with creosote, and the oil seems to have been penetrating more deeply into the wood. The wood is hard, and retains all its elasticity. On weighing the ten pieces in question, I found that they had gained in weight, upon an average, 14 lbs. (6.25 kilos) each, during their immersion from 1862 to 1864. In 1862

we found that they had scarcely increased in weight at all, but the normal weight with which we compared them was, in this case, their weight as taken in the creosoting yard immediately after their preparation; and most probably this normal weight would have been less had they been weighed in the first instance upon their immersion in the sea at Ostend.

At all events, it is certain that the weight of the creosoted pieces of wood is found to be increased after their immersion in the sea; they cannot, therefore, have lost in the sea any of the creosote oil with which they were impregnated. This circumstance is probably owing to the insolubility of the oil in the water, and also to the fact of its density being about equal to that of the sea water. It appears that, after its creosoting, and its subsequent immersion in the sea for two years and a half, the fir wood has nearly doubled in weight. It has acquired, and now retains, the density of oak.

This trial of creosoted fir for marine purposes appears to me conclusive, both as regards the preservation of the wood, and as regards its resistance to the teredo. Experiments made in England, and recently in France and Holland, tend to the same conclusion. I cannot too strongly recommend the use of creosoted fir wood in hydraulic engineering, in preference to oak (the price of which, especially for the larger pieces, has become excessive), since, in addition to its being cheaper, there is no doubt of the creosoted fir lasting longer. The Government Public Works Department has cordially adopted this most beneficial process, and constructed part of the dyke, and the whole of the American foot-passengers' bridge, in the new works at Ostend, of creosoted red fir.

At Nieuport, a visitor's pier, 600 met. (660 feet), has been built of creosoted fir, upon the left bank of the channel; and the new pier, which is to be carried out from the end of it into the sea, will doubtless likewise be made of creosoted fir. Moreover, various sluice gates at Ostend have recently been ordered to be renewed, and creosoted Baltic fir and pitch pine to be used for that purpose.

The only things about which, to my mind, we need be solicitous, are, *the proper creosoting of the timber with proper creosote oil, and the use of the proper kinds of the timber*, viz.: those best suited to the process of creosoting.

OSTEND, 5*th February*, 1854.

REPORT RESPECTING CREOSOTING AT LEITH.

3 *East Register Street,*
Edinburgh, 26th March, 1862.

Sir: In consequence of your letter to the Commissioners of the Leith Pier and Harbor Works, they appointed a sub-committee of their Board to inspect the works, and see the state of the creosoted timber, of which the Leith Pier was constructed in the year 1850.

I went, yesterday, with the sub-committee and Mr. Robertson, their engineer, to the works, when they all very carefully examined the works.

It was ascertained and admitted by all, that unprepared wood is completely eaten away by the worms, at this place, in three or four years, and that, if the piers and woodwork had not been creosoted, the whole would have been destroyed in four years.

I will now proceed to report the result of our examination :

LEITH PIER.

THE MAIN PILES.—These were very carefully examined by Mr. Robertson and the Commissioners' Superintendent, *but in no instance could they find that the worm attacked them.* They were creosoted with ten pounds per foot, and *these piles are* 1,013 *in number.*

The beams supporting the deck planks, consisting of forty-two beams, 27 feet long, 13 inches by 16½ inches, were next examined; they appeared to be perfectly sound, except in one instance; this beam was eaten all over, and must have been badly, or not at all creosoted.

The next were the walings and cross-ties; they were all perfectly sound, *except, in several instances, the ends of them were eaten by the worm; it was only in that part of their ends which had been cut*—the other portions of these pieces were perfectly free from the attack of the worm, they are 13 by 6½ inches, creosoted with seven pounds to the foot.

The iron spikes that were drawn out of the beams with the planks, were the same as if newly made; not the slightest appearance of rust being upon them, although they had been in the wood and sea twelve years. This I pointed out to the Commissioners.

To enable the Committee to see the planks properly, several of them were lifted, which showed them to be considerably eaten on the under side, except the portions that rested on the beams, which had the appearance of being newly creosoted, being wet with oil.

Although these planks have lasted twelve years, I am satisfied, that had this low landing slip been laid with

deals perfectly dry, in place of planks cut off logs, and impregnated with ten pounds of oil instead of six, there would not have been any decay at all.

These planks are not eaten in the same way as an uncreosoted piece of timber; uncreosoted timber is eaten on all sides, the insects attacking the outside and eating inwards; whereas, in creosoted timber, the insect gets in only at the heart, at the exposed end, and eats to the outside.

These planks, although considerably eaten, have, in mostly every case, the outer side perfectly square; if it had been an uncreosoted piece, the corners would have been eaten away, and the piece ultimately become round.

The only portions of the works that the Committee did not see were the sheeting piles, the tide not being low enough at the time.

This concluded the inspection.

After the examination was over, one of the Commissioners said: "I can see that the creosoting has been beneficial to the timber, so much so that, as the piles which have now been down for twelve years seem perfectly sound, I consider they may last twelve years more."

He also said that he was afraid, if the piles *had not been creosoted, they would not have been able to find any piles there at all.* As to the planking, he said it had lasted them twelve years, and they could not expect it to last forever; if they had not had it creosoted, they would have had to renew it several times; and to show that he was satisfied, he said he would propose to have the planking relaid with creosoted wood, only it must be well done.

The superintendent has proposed to have it relaid with

causewaying in place of wood, but Mr. Robertson overruled that.

I then asked to be allowed to take a cross-tie as a sample for the exhibition, which I would renew. It was proposed that I should have it, and agreed to, the superintendent being instructed to mark it off for me.

I am, sir, your obedient servant,

P. M. MOIR.

NOTE.—*The total quantity of timber required for repairs of this pier, up to the present date, July,* 1864, *has been* 400 *cubic feet.*

LEITH HARBOR.

Castlemilk Place, Glasgow, 14*th August,* 1857.

Sir: The timber for the extensive new piers at Leith Harbor, completed in 1854, was all previously prepared by creosoting.

A short time previous to my recent departure from Leith, and while resident engineer of the harbor, I made a minute examination of the piles of the piers, and was happy to find that, after the lapse of about six years, I could not discover any flaws from the attacks of the sea-worm.

* * * * * *

I may likewise mention that, for the purpose of testing the efficacy of creosoting, I placed, at various periods, several pieces of uncreosoted timber alongside the creosoted, and found that the former were completely perforated by the worm in two years' time.

I am, yours respectfully,

THOMAS MACLEAN, *Civil Engineer.*

A. FORESTIER,

INGENIEUR EN CHEF DES PONTS ET CHAUSSEES.

In a work lately published in France by Mons. A. Forestier, "Ingenieur en Chef des Ponts et Chaussees," may be found detailed reports of similar tests made for

twenty-nine years in the ports of Sunderland, Teignmouth, Lowestoft, Leith, Southampton, Brighton, Devonshire, Manchester, Plymouth, Portland, Holyhead, Ostend, and of Sables d'Olonne, and in every case creosote oil was found to be the only substance which would protect wood against the naval worm, and from dry rot and other causes of decay.

The following extracts are taken from the work by Mons. A. Forestier, above referred to, and published in Paris in 1868, entitled, "*Memoire sur la Conservation des Bois a la Mer.*"

"Our studies and experiments have entirely convinced us that of all the numerous processes hitherto known, the only one thoroughly efficacious is that which consists in thoroughly impregnating wood with creosote.

"The gates of the docks at Monk-Wearmouth, at Sunderland, were, in 1839, constructed of yellow pine treated with creosote; and twenty years afterwards, on the 5th of April, 1859, at the meeting of the Institution of Civil Engineers, Mr. S. E. Harrison reported that they were still perfectly sound, while certain pieces of Kyanized wood in the same dock were very badly damaged by the naval worm.

"In 1842, Mr. Brunel employed at Teignmouth creosoted wood, and at the meetings on November 27th and December 4th, 1849, of the Institution of Civil Engineers, he gave his assurance that these timbers had not been touched by the naval worm, while all those not creosoted had been more or less decayed.

"It was in 1846, at the port of Lowestoft, that the experiment was for the first time tried on a grand scale of using, in salt water, wood treated with creosote, the

occasion being the construction of two piers, in which not less than sixteen hundred piles were driven.

"The happy results obtained were for a long time denied and disputed, and it is said that they went even to the length of offering a reward to any one who would produce a specimen of creosoted wood attacked by the naval worm.

"In 1849, a party interested in proving the failure of the plan came, assisted by an engineer, and passed three days in examining with the greatest care each pile; and, after this long and minute search, could discover, out of the whole sixteen hundred, only six very slightly attacked, which must be considered, evidently, as a very slight exception, and of no consequence.

"This experiment is so much the more conclusive, because the port of Lowestoft is, perhaps, of all in England, the most infested with the naval worm and limnoria.

"The compilation of the facts detailed shows that creosoted wood, inspected after 7, 8, 11, 13, 14 and 20 years, has been found in a perfect state of preservation, while, after a few years, and often after a few months, other specimens of the same kind of wood, subjected to the same conditions, have been used up."

M. Forestier, referring to extensive experiments made in Belgium, by M. Crepin, gives that gentleman's own words:

"In a word, it is proven that sea water has no action on creosoted surfaces, and that the portions of the wood well impregnated preserve their penetrating odor, and present no trace of alteration."

M. Forestier also gives the conclusions reached by a Commission appointed by the Dutch Government, and

which tried faithfully and extensively various processes which purported to preserve wood. In summing up, the Commission says: "The sole thing that with any great probability can be regarded as a true preservative against the havoc to which wood is exposed on the part of the naval worm, is *creosote oil.*"

By a series of experiments, conducted in Holland, under the direction of the Academy of Sciences of Amsterdam, it was proved that "creosote oil" was the only substance which would protect wood in the shape of piles, etc., from the attacks of the *teredo navalis* (naval worm).

REPORT TO SARDINIAN GOVERNMENT.

A fir sleeper of ordinary size has a volume of 0.70 M. C., and weighs 40 K. After its injection with creosote its weight is 65 K. and it *has acquired a density equal to oak.* This property admits the use of white wood sleepers under the joint cushions, and along the inclined plane dei Giovi, where sleepers injected with metallic salts were obliged to be taken up after a few days on account of the cushion having become embedded on the wood.—*Report of G. Alby, C. E., to the Committee ordered by the Sardinian Government to consider the relative merits of the different processes of preserving wood.*—Turin, 1860.

In his evidence, given before the Select Committee on Harbors of Refuge, Mr. Abernethy said:

"I am convinced that timber, when creosoted, is not subject to the action of the worm, as far as my actual observation goes; and in that case probably I am understating it when I say it would last for half a century at least."

LOWESTOFT HARBOR, NORFOLK.

The earliest wood creosoted and exposed to the sea in harbors was used at Lowestoft; and Mr. Sinclair, the engineer of that harbor, made the following statement at the Engineer's Institute, on April 5th, 1859, regarding it:

At the meeting at the Institution of Civil Engineers, Mr. T. E. Harrison remarked that the entrance gates of the Monk-Wearmouth docks at Sunderland, which had been constructed of yellow pine, creosoted twenty years ago by Mr. Brunel, were quite sound, but portions of Kyanized timber, used in the same works, had been attacked by the worm to a considerable extent.

MANCHESTER, SHEFFIELD & LINCOLNSHIRE RAILWAY, GREAT GRIMSBY DOCK.

Engineer's Office, August 20th, 1857.

Dear Sir:—I am very glad to bear testimony to the very satisfactory result creosoting has had upon the hundreds of piles used in the construction of piers of the Tidal Basin for the entrance to the Grimsby Docks, which has been done for seven years: none of the timber which was creosoted is in the least decayed or affected by the worm, whereas, other piles, which were driven alongside by mistake, and not having undergone creosoting, have been nearly destroyed by the worms, and are also considerably decayed. I can highly recommend the process as being the most sure and perfect preventive against all sea-worms and decay in timber; but much depends upon the oil being properly injected into the timber, to produce a satisfactory effect.

I am, dear sir, yours truly,

ADAM SMITH,

Dock Engineer.

PORTLAND BREAKWATER.

Engineer's Office, Portland, 24th August, 1857.

Dear Sir:—In reply to your letter of the 22d inst., making inquiry as to the efficacy of creosoted wood in resisting the

attacks of sea-worms, I am happy to be able to inform you that, so far as our experience will enable me to speak, the result of the impregnation of the timber with creosote has been most successful and satisfactory.

* * * * * *

As an instance of the successful application of creosote, I may mention that about two months since it became necessary to remove some piles that had been down four years, and fully exposed from above the level of high water to nearly fifty-five feet under sea-water; *there was no sign whatever of any attacks by sea-worms*, notwithstanding that we have "Teredo Navalis" and "Limnoria Terebrans" in the bay, the latter in great numbers, and most destructive to unprepared timber. I have known three-inch plank unprepared eaten quite through by them in about three years, at a point not very far from the site of the piles alluded to.

I am, yours truly,

JOHN COODE,

Engineer-in-Chief.

PROFESSOR BAIRD,

OF SMITHSONIAN INSTITUTE, WASHINGTON,

In an article published in the Philadelphia *Ledger*, on timber used for marine purposes and its security from decay and attacks of sea-worms by use of creosote oil, says:

"To a maritime nation there are few subjects of greater practical importance than the prevention of the ravages of the *teredo*, or borer in timber immersed in sea water, whether in the form of boats and ships, or piles, wharves, etc. Many remedies have been proposed, some of them beneficial for a time only, others entirely worthless, and the encasing or covering the surfaces exposed to the water with copper or other metal has hitherto been the only permanent means of defence, and this only useful as long as the shield remains unbroken.

"Our attention has recently been called to a series of experiments conducted in Holland, under the direction of the Academy of Sciences of Amsterdam, and a report just made embodies so many important conclusions, that we present some of them for consideration here. It may be well to premise that the "borer" in question is not a worm, as frequently supposed, but one of the mollusca or shell family, which, floating freely in water when young, and almost invisible, attaches itself to timber, and with its two extremely minute shells, working like an augur bit, bores into the substance of the wood, and increasing in size with age, excavates a long tubular gallery, lined with

a shelly deposit. The wood is not consumed for food, but only bored out to afford the proper lodgment for the animal. Its tail is provided with two small wire-like siphons, which, serving to catch the minute animalcules on which it is nourished, project beyond the surface of the wood into the water, although readily retracted at will.

"The experiments in question were prosecuted simultaneously in different harbors, and with piles of oak, pine and fur, some of which were prepared with the different remedies and others left in an exposed condition. Three classes of experiments were made—one, the coating the external surface only with paint or other substances; another, the impregnating the surface and the outer portion of the wood with different preparations, and another, the use of timber different from that usually employed.

"Under the first class, experiments were made with a mixture of tallow, coal-tar, rosin, sulphur, and powdered glass; paraffine varnish, obtained by the dry distillation of peat; coal-tar; oil paint of different bases; by carbonizing the surface of the wood; driving it full of broad-headed nails; coating it with zinc or galvanized iron, and by applying a number of secret preparations presented for the purpose. None of the remedies gave satisfactory results. Some had absolutely no effect, and others diminished the evil only in a trifling degree; while even in the latter case, any abrasion of the surface caused by floating ice or other means, or the cracking of the wood, allowed the entrance of the teredo to an injurious extent.

"Under the second head, trial was made of sulphate of copper, sulphate of iron, acetate of lead, corrosive sublimate, soluble glass, chloride of calcium and chloride of

zinc; tar oil, creosote oil, etc. Of these the creosote oil experiment alone presented any positive indications of beneficial result, and in it the committee found what they sought for. After five years of exposure, while all the other piles, whether prepared or not, were entirely eaten up, those impregnated with this substance were perfectly sound and free from any trace of the worms. In experiments of the third class, various woods were tried; some of extreme hardness, and others reputed to be poisonous, but all were more or less affected by the worm.

"The report of the committee sums up with the following conclusions: 1. That mere external coating of the timber with paint or other substance is of no avail; since it is impossible to maintain an unbroken surface, the young teredo will enter the slightest crack or abrasion. The use of copper, zinc or galvanized iron plates is too expensive for most occasions; and even these become of no use when broken. 2. Impregnating wood with soluble inorganic salts which are poisonous to animal life, furnishes no protection against the worm. This is due to the fact that the sea water soon dissolves away their strength, and that the worm does not devour or digest the wood bored out by means of the shelly jaws. 3. The hardness of the wood and its poisonous character, as far as known, furnishes no protection. 4. Creosote oil is so far the only substance met with that constitutes a true protection against the worm. Attention should therefore be directed to the best and quickest methods of saturating the wood with this material, and to the kinds of wood most absorbent of it. As the creosote oil doubtless owes its peculiar powers in the respect just indicated mainly to the carbolic and cresylic acid it contains, we have another illustration of

the important applications to be made of the latter substances in our domestic and industrial economy. Some of these we presented in an extended article, published last summer, and new uses are constantly being brought to notice. The pure acids are probably too soluble to be of the same use in the preservation of sea timber as the creosote oil, and are also much too expensive; but they may doubtless be employed to advantage on a small scale, when the other substance cannot be had.

"In conclusion, we may call attention again, as we have already done, to the fact that a similar impregnation of timber with creosote oil for railroad sleepers and other purposes, involving burial in the ground, will be an effectual protection against dry rot and similar causes of decay."